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Acquisition of Maternal Education and its Relation to Single Word Reading in Middle Childhood: An Analysis of the Millennium Cohort Study

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Abstract

Maternal education captured at a single time point is commonly employed as a predictor of a child's cognitive development. In this paper we ask what bearing the acquisition of additional qualifications has upon reading performance in middle childhood. This was a secondary analysis of the UK's Millennium Cohort Study, a birth cohort of 18,000 children born in 2000. Our outcome variable was Single Word Reading from the British Abilities Scales at 7 years. Predictors included maternal age and education, relative poverty and parity. Increasing maternal education over time was associated with improved child outcomes with a 2 month developmental advantage for children whose mothers had increased education over those whose mothers had not. Parity was important but conditional on this, there was no evidence of child attainment reducing for the children of older mothers. A time-varying education level model is consistent with an input quality mechanism for language development.

Acquisition of Maternal Education and its Relation to Single Word Reading in Middle Childhood: An Analysis of the Millennium Cohort Study

Early child development in general, and oral language and literacy in particular, are associated with social advantage (Maggi, Irwin, Siddiqi, & Hertzman 2010; Hoff, 2006; Hart & Risley, 1995): there is a social gradient (Marmot, 2010; Law, Reilly, & Snow, 2013) as well as resilience in more disadvantaged families (Schoon, 2006). A number of different mechanisms have been posited for this social gradient in terms of both proximal environment and behavioural genetics, which are likely to be interrelated (Hart, Logan, Soden-Hensler, Kershaw, Taylor, & Schatschneider, 2013; Harlaar, Dale, & Plomin, 2007; Trzaskowski et al., 2014). Numerous associations have been demonstrated between social disadvantage and language development (e.g. McCormack, Harrison, McLeod, & McAllister, 2011; Taylor, Christensen, Lawrence, Mitrou, & Zubrick, 2013) without establishing causes of observed disparities in populations. Control by randomisation in small experimental studies, such as those evaluating Head Start interventions (Barnett, 1998; Heckman, 2013), makes understanding effects representing the full range of social difference very difficult. In general, studies of child development outcomes account for socio-economics using a proxy variable in the analysis, or by matching control groups, understating the strength and breadth of the association with language outcomes observed in large empirical studies.

Socio-economic status (SES) can be measured as income, housing (type and tenure), occupational status, and parental educational attainment at an individual or a household level, or by proxy of area deprivation. Although relative poverty (i.e., income below the poverty line) is established as a risk factor for negative child outcomes (Huston, McLoyd, & Garcia Col, 1994), poverty alone cannot explain gradients observed higher up the SES scale. For example, parents' economic and social context influence parental attitudes and aspirations, the educational and cultural opportunities for children (Bennett et al., 2009), while resource limitations preclude certain activities beyond the home. The quality and nature of a child's early home learning environment is both strongly associated with their developmental outcomes, and influenced by a range of SES factors and cultural practices (Johnson, Martin, Brooks-Gunn, & Petrill, 2008; Froyen, Skibbe, Bowles, Blow, & Gerde, 2013). The availability of books (whether or not for the child to read) is an example, and one which is often described as reflecting cultural capital as it reflects investment in cultural resources.

Behavioural genetics can ascribe a large amount of variation in language ability to heritability (Hart et al., 2013; Harlaar et al., 2007), implying that environmental intervention has constrained potential, beyond the known toxicity of extreme privation. Earlier analyses rest on the zygosity of co-twins, who do not have typical language development (McEvoy & Dodd, 1992), and make further assumptions about the equal environments they experience, while not measuring what is shared or input for environment (Shonkoff & Phillips, 2000; Trzaskowski et al., 2014). Detailed study of language outcomes shows that some aspects are more related to environmental factors than others; specifically comprehension and culturally-based measures have less heritability (Hoekstra, Bartels, van Leeuwen, & Boomsma, 2009). While it has been proposed that gene-environment interactions could still play a role here, evidence from studies of candidate genes is very weak (Jerrim, Vignoles, Lingam, & Friend, 2015) and Genome Wide Association Study (GWAS) analyses have been unsuccessful in identifying the root of the large heritable component (Tran, Gagnon, Wigg, Feng, Gomez, Cate-Carter et al., 2013). There is some suggestion that genes may even influence SES (Trzaskowski et al., 2014), but careful attention to SES measurement and missing data has shown earlier effects to be overstated (Jerrim et al., 2015). Thus Genetic Complex Trait Analysis (GCTA) is proposed by behavioural geneticists as combining the genetic and SES dimensions to predict cognitive outcomes (Trzaskowski et al., 2014).

SES as a developmental mechanism

SES in the context of both child development and language/literacy is often conceptualised as maternal education (Dollaghan et al., 1999; Hoff, 2006; Shonkoff & Phillips, 2000). Although maternal education is likely to be associated with other aspects of SES such as occupational status, educational level specifically has been found to be associated with the observed variation in the nature of parent-child interaction (Hart & Risley, 1998), with ensuing advantages for children, including shared attention and well developed attachment. Studies looking at the antecedents of early language/reading have seen restricted maternal input has a bearing on later reading skills and that this is commonly associated with maternal education (Buckingham, Beaman, & Wheldall, 2014), and holds when heredity is considered. In a large twin study from the UK, shared environmental factors explained most of the association with literacy at age seven (Oliver, Dale, & Plomin, 2005), although a recent review of literacy intervention suggests demographic factors do not predict response to interventions (Lam & McMaster, 2014). Parental phonological awareness, family history of reading difficulties and school SES independently predicted whether a child was likely to experience difficulties (Heath et al., 2014): maternal education dropped out as a predictor once the other variables were added into the models, suggesting they mediate its influence. Environmental factors are shaping developmental outcomes (Rutter, 2005) but longitudinal analysis of representative population studies is required to separate structures of influences and understand mechanisms (Hulme & Snowling, 2009, p.347). Yet, as a mechanism, maternal education presents a challenge by being difficult to modify directly through intervention, confounded with other factors such as propensity to participate in research, and will require a long time to have an effect.

In their seminal study of the natural language development of a sample of children (N=42) through to 30 months of age, Hart and Risley (1995; 1998) examined the development of three groups of children classified according to parental employment status (professional, blue collar, welfare). Parent education was highly correlated with the occupational groups used, relating to expectations and behaviours of the parents (Shonkoff & Phillips, 2000), which are, in turn, closely associated with early reading skills **(**Scarborough, 2009). Hart and Risley (1995) found that children of parents in professional occupations were exposed to a much larger functional vocabulary compared to children of parents in blue collar occupations or parents receiving welfare payments. The occupations of parents or income of the families in Hart and Risley's (1995) study do not obviously drive parents' engagement and interactions with their child. Although the sample was small and their categories confounded with other factors, such as race, the detail of the parent/child interaction showed profound differences in the character of maternal responses to child utterances and resultant vocabulary between the three groups, a finding replicated by Hoff (2003).

SES, whether represented by parental occupation, education, income and any other environmental measure, is one driver of the child's development and other developmental factors are especially important in the early years (Christian et al., 1998). Parity (or birth order) has a strong influence on child developmental outcomes: In larger families, parental resources are more thinly spread so children receive less individual parental attention such as child-directed speech (Berryman & Windridge, 2000; Coates & Messer, 1996; Tomasello & Mannle, 1985; Prime, Pauker, Plamondon, Perlman, & Jenkins, 2014; Dunn & Shatz, 1989; Hoff-Ginsberg, 1998; Jaeger, 2008; Hoff-Ginsberg & Krueger, 1991; Hart & Risley, 1998). A deleterious effect is observed to increase in size as parity increases (Jaeger, 2008) and twins exhibit similar delays relative to singletons (McEvoy & Dodd, 1992; McMahon, Stassi & Dodd, 1997) although most studies lack the power to test anything but the difference between large and small 'sibships' (i.e. the group of siblings in the household) and are confounded by SES determinants of family size (Ghilagaber & Wänström, 2015). The observed sibling effect is moderated to some extent by maternal age and experience (Berryman & Windridge, 1991) and, to a degree, related to the 'cognitive sensitivity' of the sibling (Prime et al., 2014). So family socio-demographic variables interact with one another (or combine as the child's social environment) at specific points in a child's development.

Social variables are commonly used as fixed predictors or risk factors for developmental outcomes of language and literacy in populations but by using longitudinal prospective data it is possible to study relations across time (Shonkoff & Phillips, 2000). Most research is testing for divergent outcomes in children, so changes in the family are usually viewed from a perspective of specific disruptive events e.g. changes to the household membership or location (e.g., Melhuish et al., 2008). A number of family characteristics, known to be cumulatively important to child development, have the potential to change over time, and affect different aspects of child development (Davis-Kean, 2005; Hoff, 2006; Ermisch, Jantti, & Smeeding, 2012; Becker, 2012). A parent's occupation may not be stabilised until their thirties (Sturgis & Sullivan, 2007), and earnings (or social class in general can) increase with age (Bennett et al., 2009, pp. 53-54). Inferences from any analysis of parental SES and child outcomes is likely to be a function of the point at which data are collected during the family's life course (Halfon, Larson, Lu, Tulli, & Russ, 2014).

Participation in post-compulsory and in higher (undergraduate and postgraduate) education has increased enormously in recent decades (Hordern, 2012) and often extends into the age in which child bearing commonly takes place. Further education for low skilled adults is a step towards a professional career, but it is also posited to have an impact on both the parent and their children (Sullivan, K. et al., 2011). As the parent obtains more education, their educational engagement and aspirations for their children improve, as does the home learning environment and educational experiences provided. Further education can also be a signal of disposable time or income as well as more "middle class" child rearing behaviours or parenting style. For example, providing more educational trips for their children and being more involved in school (parents' associations etc.), higher expectations for their children (Sullivan, A., Ketende, & Joshi, 2013), leading to improved outcomes. However, specific job relevant skills would link directly to income, and hobby courses of personal interest suggest recreational or cultural motivation. Improved outcomes for children associated only with an increase in maternal education is predicted by a socio-cultural and direct input interpretation, although perhaps not something easily measured in the home environment (Magnuson et al., 2009). A mechanism corresponds to changes in how the mother behaves towards the child, as direct interaction and experiences in the family are more relevant in early childhood.

While many studies look at how SES and maternal education in particular affect early literacy outcomes (e.g. Christian et al., 1998), we only identified a single study which sought to test the specific effect of the accumulation of maternal education. Magnuson, Sexton, Davis-Kean, and Huston (2009) investigated education increases and child language at age three, in a targeted sample of just over 1000 predominantly low income parents in the USA (the NICHD). The mother's educational level was classified into five groups, each corresponding to a further two years of successful duration (none/unfinished; high school; some college (e.g. associate); college degree; graduate school). A positive association between increased education and child language gains was present and significant for those who were least well educated but not overall as the study was underpowered (only n=53 parents increased their education). Although increased education was associated with improved performance on the Home Observation for Measurement of Environment ([HOME] Caldwell & Bradley, 1984), the effect of parental education gains on child language was not mediated by a change to the environment at age two on the HOME. Thus the hypothesis of more enrichment in parental interaction and child stimulation was not supported.

Child development measures are sensitive to timing of assessment: Language is a complex multi-component skill involving interactions between subcomponents both in the act of language processing and also over developmental time. Language interacts with the development of early literacy skills throughout childhood, so skills gained in one component cascade onto the learning of others with different developmental windows (Shonkoff & Phillips, 2000). This complexity is mirrored in the choices made to measure language in cohort studies: in the early years the emphasis has tended to be on expressive vocabulary, although there are concerns about bias in some parental

reports (Law & Roy, 2008), and later emphasis tends to shift to letter knowledge and early literacy. Early measures tend to be relatively unstable and unreliable; the profile of children's skills changes over time for a range of developmental and environmental reasons, so reading only becomes a useful indicator of attainment once the child is well established in primary school or kindergarten. Stability increases with age and for this reason assessing the impact on the child's abilities at seven or eight years of age should be especially relevant (Feinstein & Brynner, 2004). Examining these mechanisms in middle childhood allows focus on the developmental stage when most input has been from the mother as a primary carer, while allowing enough time and change for benefits to accrue from improving social circumstances.

Research questions

The aim of the study was to examine the impact of changes in maternal education on the literacy skills of children in middle childhood in a representative population.

Our research questions were as follows:-

1. Does a mother's acquisition of new qualifications over the first seven years of life have a bearing on the child's reading skills in middle childhood?

2. To what extent is this relation affected by maternal age, parity, gender and income?

METHOD

The data are from the Millennium Cohort Study (MCS) in the UK, comprising prospective longitudinal data on a cohort of children and others in their household. The MCS is a nationally representative cohort of around 19,000 children born in the UK in 2000-1, spanning births in a full 12 month period. Informed consent was received from mothers and partners for participation in the study for themselves and their children and verified at each later sweep of data collection. Children's households were sampled randomly from a register of those receiving Child Benefit which has estimated coverage of 97% of children resident in the UK. The MCS was designed to oversample areas of high deprivation in anticipation of greater attrition in those areas, and the devolved nations of the UK to increase the power of subgroup analyses (Plewis, 2007); thus all population estimates require design weights which are utilised throughout the analyses presented (subsample totals rounded to whole persons).

Families were first interviewed when their child was around 9 months old and were followed up when the child was 3, 5 and 7 years old. Over 13,800 families with over 14,000 cohort children took part in the age 7 survey; 90% of families who took part in all the previous MCS sweeps (9 months and ages 3 and 5) also participated at age 7. The present analysis includes those children who were assessed using the British Ability Scales (BAS II) single word reading (Elliott, Smith, & McCulloch, 1997) at seven years of age (N=12,845: males n=6574 (51.2%); females n=6271 (48.8%); versus not completed by n=427 children). This excludes further observations where there is not enough information, the child or the mother had died, or the primary respondent was not the mother (in total n=296 of original sample were not considered). Mothers holding overseas qualifications were excluded due to the heterogeneous and uncharacterised level of such qualifications (n=527). Twin pairs and triplets (n=312) were also excluded due to their known anomalous language outcomes (McMahon et al., 1997), and their problematic specification in terms of the birth order effect, but as multiple births are random their exclusion does not affect our analysis. The sample is statistically representative of singleton children born in the UK in 2000-1 whose mothers were their primary carers and had British educational qualifications.

Variables

Information about maternal education was recorded when the child was nine months, and followed up at three, five and seven years and is the qualification level (rather than the duration of schooling as is sometimes used) as this better reflects the hypothesised mechanism. At first interview, the mother was asked for her highest qualification, both academically and vocationally; in each subsequent interview the mother was asked:

"I'd now like to ask a few questions about your education and qualifications since [child name] was aged [last interview age]. Have you acquired any new qualifications?"

Followed, separately for showcards listing academic and vocational qualifications, by:

"Please tell me which of these qualifications on this card you have gained since [child name] was [last interview age] old?"

Vocational (as opposed to academic) qualifications are more difficult to classify and interpret, are less homogeneous and less predictive (Sullivan, A. et al., 2013), so the study focuses on academic qualifications in line with the hypothesised level of education mechanism. The data for maternal education at the child's birth was coded into four levels:

1. Higher Education;
2. A levels;
3. O levels/GCSE A*-C;
4. CSEs/ GCSE D-G and None.

Higher Education covers qualifications from a foundation degree (i.e. less than a bachelor's degree) and higher diplomas and certificates, up to postgraduate qualifications in teaching, and higher and research degrees. Further subdivision of the 'Higher Education' category was impractical for the range of qualification, and a change to the coding scheme used in the data collection between sweeps 2 and 3. In England, Wales and Northern Ireland, 'A' (Advanced) levels are required for university entrance and are typically completed by 18 years, when children have usually leave school. The General Certificate of Secondary Education (GCSE) is completed during compulsory stages of education (usually by 16 years) where attainment is split into passing (A*-C) and failing (D-G) grades. The lowest category indicates very limited attainment: essentially no employer recognized qualifications. Scottish qualifications have been coded for equivalent levels. Comparing broadly to Magnuson et al. (2009), in the US system, we have: HE = associate, bachelor and graduate degrees; A levels = graduated high school (age 18); GCSE A*-C etc = some high school but left before graduation (age 16); GCSE D-G/None = failed high school/no high school. Variables were derived to record acquiring new education during the years between the child's birth and the outcome at age 7. We enumerate gains in terms of whether or not they raised the educational level of the mother on the four point scale described above from her original report. We assume no further qualifications were achieved between the birth and the first interview and we consider only whether a gain has been made at all and the type of gain, not the sweep at which it occurred.

To complement the SES effect of maternal education, we use a binary threshold risk factor for material deprivation (Huston et al., 1994; Hoff, 2006). 'Poverty' is derived from the OECD equivalised household income recorded at first interview, compared to the standard threshold (60% of median household income), after adjustment for household membership. Absolute values of the index are not meaningful but it measures relative household income and the 60% threshold is an indicator of material deprivation. Maternal age at child's birth is categorised in five year bands, with under 20s and 35+ as open ended groups. Initially 6 year bands from 20 were considered in anticipation of a different pattern for children of older mothers but as none was observed and the group size was small for mothers aged 38+, the five year bands were preferred for familiarity. Parity (birth order) was included for individual values up to 4 and then remaining values grouped together as 5+ (highest value was 9).

Sample characteristics

The first two columns from the left of Table 1 show proportions having each attribute for mothers respectively: of the sample completing the word reading, and the full MCS sample; the remaining columns present these proportions for various categories of educational gain. Mothers who are more advantaged, highly educated and older, while having their first child, are more likely to have been excluded from the sample, but none of these differences are large enough to prejudice inference to the reference population. Overall there are roughly equal proportions in the modal age groups of 25-29 (28%) and 30-34 (29%); similarly the adjacent age groups of 20-24 and those over 35 are roughly equal in size. Most births (41.4%) are the mother's first but nearly as many are their second (36.1%). Most mothers had only school leaving (at age 16) qualifications: more than one third had good GCSEs (36.0%) and 28.6% less than that or no formal academic qualifications, while 26.2% had university level qualifications.

TABLE 1 ABOUT HERE

In the fourth column of Table 1, we see more than 600 mothers making a gain in their educational level from when the child was nine months old to seven years old. Although this group tended to be younger, and more likely to be in poverty, than the rest of the population, they were not substantially different in terms of their parity: these are women having their first child at a younger age, interrupting their education before gaining further qualifications. Conversely in column 3, those gaining qualifications but not at a higher level, are more likely to be older, not in poverty and having had their second or third child, although they are also likely to have had university qualification at the time of the child's birth: they are at a more established stage of life. Finally, in column 5, we also consider a variable for a specific gain in educational level (A levels), a subgroup of the general gain group and not dissimilar in the proportions of mothers with each of the socio-demographic characteristics.

Outcome variable

The outcome was the Single Word Reading test of the British Abilities Scales (Elliott, Smith, & McCulloch, 1997), an age-standardised direct assessment requiring the child to read a series of increasingly difficult single words. This is a personal face to face assessment, in this case performed by the same interviewer who completed all of the other questionnaires, with the parent present. The standardisation covers 65 to 145 (100 ±3SD) but in a large, representative population we expect to observe floor and ceiling effects: The slightly offset population mean resulted in a larger proportion of children being at ceiling. The Ability Score (before age-standardisation) was used to extrapolate those at ceiling. Intentions to interview all families when the child was aged seven years, realised a range in the months of age at assessment (M 86.6, SD 2.97). Thence, using age, Ability Score and Standard Score (originally constructed as a linear relation), we derived the differences above or below the average for the whole sample and use this transformed value as the dependent variable in our models to facilitate interpretation of the effect size as months of developmental difference.

The analytical approach

We estimate the most parsimonious model based on mechanisms for the variation in population language development, specifically in relation to SES (Hoff, 2005). This includes variables for gender and parity together with two complementary measures of social risk (household poverty and maternal education) with maternal age giving some demographic context. Many proximal activities may influence the outcome during the child's development, but our analysis estimates some of the more distal SES effects already established when the child is born. Furthermore, Magnuson et al. (2009) were unable to establish a mechanism for the observed effect by influence on the HOME score (Caldwell & Bradley, 1984) whilst finding a significant direct

effect. Thus we are estimating the relative population difference of variables fixed at (but recorded soon after) the birth of the child to allow a robust estimate of the effect on the outcome associated with an increase in maternal education, controlling for gender, maternal age, and baseline SES.

All of the analyses were performed in Stata v13.0: The models used OLS regression to predict the outcome, weighted to make a representative inference about the native UK population, using the population mean as the baseline for the model estimates. Categorical predictors allow more parameters to be used than for continuous variables and facilitates estimates of possible relations which are not linear, but rests on an assumption of homogeneity within categories. Inference is relative to a reference category chosen as the largest group: the child being male, mothers aged 30-34 at the birth of the child, the child being their first born, having an educational level of good GCSEs (similar to having graduated from high school, but at the normal age of 16), not being in income poverty, and not gaining further qualifications in the period. Separate models, conditional on the same covariates, are estimated to test the three distinct specified gains to maternal education:

1. Further education which increases the mother's educational level;
2. Any other further education (termed lower or equivalent level qualifications);
3. A gain of A levels representing an increase in highest qualification.

Specification 3 is chosen to be the most homogeneous type of change and therefore the most powerful estimate of an effect, corresponding to the subgroup finding of Magnuson et al. (2009) of completing high school, but it is a subset of the first specification.

The covariates specified above (maternal age, gender of child, initial maternal education, poverty indicator, maternal education gains) are not complete in all cases. Where items such as maternal age, gender or birth order are missing at the initial sweep they can be retrieved in later sweeps of the study, as can poverty, while unit non-response at age 7 is accounted for by weights. As the design of the MCS used a third party sampling frame that is updated periodically, initial recruitment missed some children (n=692) who were then contacted for the first time at age three. Three variables retain item level missingness: the poverty indicator (n=477), initial maternal education (n=460), and consequent gain of education in the first three years of the child's life. Multiple Imputation by Chained Equations was used and all model estimates are based on 20 imputations (Royston, 2004; Rubin, 1987).

RESULTS

Independent predictions of the single word reading outcome are seen in Table 2 and show the anticipated differences with girls above the population average by more than one month and boys below by a similar amount. Poverty has a substantial negative association (six months below average) with the outcome (single word reading) and so does every increase in parity and, because of the large sample size, these differences all have statistical significance. Educational level showed the expected pattern: high maternal education is associated with above average outcomes and vice versa; maternal age saw an increase in predicted outcomes up to age 30, followed by a slight decline for the oldest mothers. There is an effect of education as a manifestation of SES, but education level is dependent on maternal age, such that attainment characterises a different range of life courses at different ages. In Table 3 we can see by considering a cross-tabulation of maternal age and maternal education that the association between the two is pronounced; this interaction between the two variables is included in the multivariate analyses. The principal interest here is in the main effects of the maternal education levels and the poverty indicator, but these effects are associated with (and therefore confound the estimates in Table 2) the levels of the maternal age variable. Hence we initially abstract the effect of the interaction from the remainder of the variables.

TABLE 2 ABOUT HERE

TABLE 3 ABOUT HERE

Figure 1 shows the combined estimated effects of the variables for maternal age and initial maternal education, fitted as an interaction in the models. As zero corresponds to the reference category for other variables i.e. being male, first born and not in poverty, almost all estimates appear to be above average. Maternal education levels are strongly predictive of the child's reading skills at seven years while being complicated by the effect of the maternal age at birth, and the large sample allows us to consider the patterns as robust. The scale of the differences seen is substantial being an estimated mean developmental difference of nearly 6 months at age 7 for mothers aged 20-24 between mothers who have higher education and those who have no qualifications, rising above 9 months for the same difference in mothers who are over 30. The trend between age groups identifies those with higher levels of education as seeing higher child outcomes at age 7 by roughly 2 months development being in an older age group from 20-24 years to 25-29 years and again from 25-29 years to 30-34 years but perhaps only half that for those without good qualifications. There is an anomaly in the estimate for the (n=17) youngest mothers with the highest level of qualification who have by far the worst child outcomes: This is a very small group not old enough to have completed a bachelor degree, perhaps corresponding to community college or associate degrees.

FIGURE 1 ABOUT HERE

1. *Is a mother's acquisition of new qualifications over the first seven years of life have a bearing on the child's reading skills in middle childhood?*

Table 4 shows the estimates for gains in education, given all covariates and [maternal age × initial education] interaction described above (equivalent models for the three proposed educational gain variables show similar covariate effects) in the first research question. Gain in educational level has three types, its effect on the cognitive outcome is shown in Table 4: an educational gain to a higher level has a positive association which is marginal in terms of statistical significance (95% CI [0.3, 3.4]). The lower and equivalent level qualifications (LEL) shows an insubstantial and slightly negative effect, associated with exclusion of those gaining both lower and higher qualifications in the period. A levels gains are associated with a higher child outcome and we can compare the estimated effect (a gain of 4 months, 95% CI [0.9, 7.8]) to the estimated difference between the two levels of education. The estimated association of benefit for later gain generally exceeds the penalty of not having that level of education at the child's birth. This would likely relate to either further subsequent gains, or starting from a lower level than the good school leaving qualifications of the category below; it may also exaggerate the effect due to a selection bias. We replicate and extend the results observed by Magnuson et al. (2009): with generally positive, significant effects of gain to educational level and specifically of advanced school leaving qualification.

TABLE 4 ABOUT HERE

2. *To what extent is this relation affected by maternal age, parity, gender and income?*

In this question, we see further in Table 5 all of the model effect estimates for the variables the covariates included (gender, parity and poverty), in the model for A level gain. Parity has an effect of around two months delay to the cohort child for every preceding child the mother has had (the estimates use dummy variables for each we see a simple additive effect, petering out for the largest families) notably with the difference between first and second born at around a very high level of significance, (CI [1.4, 2.8]). Reading this with the effect of maternal age, as a mother is necessarily older when having subsequent children, parity still has a negative effect. As is typical in language development, we observe that girls have an advantage at age 7, of nearly 3 months (CI [2.1, 3.3]) on the single word reading measure. Finally, we see that the effect of poverty also corresponds to a developmental delay of around 4 months (CI [3.0, 4.7]), in terms of word reading, controlling for the other effects in the model, showing that maternal education does not capture the

whole of SES association with the outcome, but the effect is considerably reduced from the 6 months shown in Table 2.

TABLE 5 ABOUT HERE

From the whole model we predict substantial difference in the language development of children at age 7 based only on information available at their birth. While some of these are more biological circumstances such as gender and birth order, substantial effects are associated with social factors. The pattern shown in Figure 1 is one of improving prospects for child language outcomes associated with both the age and the education of the mother. While both maternal age and maternal education have an effect, these interact so education sees a greater benefit at older ages, or conversely, there is a greater negative association of a mother having no qualifications at an older age. Contrasting extremes, the group with the lowest qualifications with a child born before they are 20, their child has a disadvantage, relative to the group of children born to mother with higher education aged over 30, of more than a year at the age of 7. There is a social gradient across levels of education, particularly noticeable in the modal group of mothers which lends itself to more precise estimates, and this social gradient is more pronounced amongst children with older mothers. Finally, very little difference is observed between ages 30-34 and 35+, remembering that the model is conditional on parity which obviously increases with age, so explaining the divergence from univariate estimates in Table 3. These estimates allow for a negative effect of household poverty on child outcomes, suggesting the underlying maternal education has substantial explanatory power, replicating a pronounced social gradient (c.f. Marmot, 2010).

DISCUSSION

The developmental staging of early literacy and oral language is a complex function of exposure and experience in the sense that synthetic skills are likely to reflect what the parent and others (e.g. teachers) do to engage with the child. We found that on average, in the UK, the more education that the mother has, the higher the child's reading scores at seven years of age, and specifically increasing her educational level during this time is associated with a better outcome. More subtly there is a greater difference for older mothers, on top of better outcomes for the children of older mothers more generally; we describe this combination as an association of 'maternal maturity' with better early literacy outcomes for children. This age benefit is offset by a negative effect of birth order, with second and later children having poorer outcomes, consistent with disruption of beneficial exposure, and shared parental resources more generally. So although 'maternal maturity' definitely matters for the child outcome, opportunities for adult education do not require postponing childbearing until after further education as the eponymous Rita perceived:

"I've been realisin' for ages that I was y'know, slightly out of step. I'm twenty-six. I should have had a baby by now; everyone expects it. I'm sure me husband thinks I'm sterile. He was moaning all the time, y'know, 'Come off the pill, let's have a baby.' I told him I'd come off it just to shut him up. But I'm still on it. See, I don't wanna baby yet. See I wanna discover meself first. Do you understand that?" (Russell, 1995, p. 271)

All educational levels show greater benefit to the child with increasing maternal age, notwithstanding the additional benefit of increasing education and interference of older siblings. We do not see any reduction in prospects for children of older mothers, but the two groups of mothers aged over 30 are consistent (an initial analysis based on 6-year age groups from 20-25 etc showed the same pattern despite yielding 38+ as the oldest category). Poorer prospects for children of older mothers (seen in Table 2) are related to the increase in parity, which is not, at that age, offset by benefits from increasing age. Indeed the consistent effect of parity, even of the child being a second child, is striking; but household financial resources may constitute a selection effect which

prejudices interpretation as a natural experiment (Ghilagaber & Wänström, 2015), yet the observed effect exceeds potential selection bias.

The combined socio-economic effects (poverty discriminates within the lowest level of qualifications) are associated with more than one year of development (or more than one standard deviation of difference on the standard score scale) of the Word Reading task representing large differences between broad population groups rather than a determination of prospects for all children. Maternal education is additive, implying differences being due to a change in the mother, in terms of higher social status, or a shift in the character of direct language input. We observe an improved outcome for children when their mother has increased her education level since they were born, particularly proceeding to university entrance level, but no difference for other further education. A selection effect for households with capacity for time in education should not be limited to increases to the mother's highest attainment. Studying reduces the time the mother can spend with her children, so higher qualifications which larger commitments may not see a benefit, or one which takes a longer time to be seen in outcomes. Thus the SES relation to language outcomes is not completely determined by maternal education when the child is born but the mechanism can be quality of maternal language input (c.f. Hart & Risley, 1998), latent social status (Sturgis & Sullivan, 2007) or other cultural aspects of later attained SES (Bennett et al., 2008).

Study limitations

The MCS data focus on the children in the cohort, and are directly comparable as a sample of births in the UK within one year, so mothers are parenting at the same period of time but maternal age effect estimates may relate to diverse formative experiences. The range of more than twenty five years which covers the mothers in the cohort corresponds to the mothers themselves leaving school between roughly 1975 and 2000, a period in which both the prospects for women in society and the norms of the school educational system have changed. The school leaving outcome expectation changed: all children are entered for the higher level of school leaving qualification, so some say the GCSE qualification does not represent the same standard as the O levels it replaced. In our model, we see better outcomes for that group, compared to adjacent educational levels, for the children of 35+ mothers, in evolving prospects for young people entering the labour market straight from school.

The relation, shown in Figure 1, between the level of maternal education with the outcome, coupled with the positive effect of gains suggests that it is the experience of exposure to education, and associated maturity, that is affecting literacy in middle childhood. An observed association may represent unfinished education attained by parents who were too young, meaning gains were only returned to younger mothers. However, there can be something inherently different about the mothers who go on to further and higher education prior to their further engagement in the education which is driving the differences at seven years. They can be more orientated towards educational activities, more cognitively sensitive than other parents or more aware of what "needs to be done". Then maternal educational level becomes an indicator of an underlying predisposition rather than the mediator of the process, and it is those mothers who go back to education, rather than the education, creating the association. Although the direct effect of exposure to higher levels of education has face validity in terms of increased language skills and increased intellectual curiosity and a more critical approach to questioning and knowledge, a cohort study does not provide causal evidence. Specifically, possible restrictions on maternal opportunities for further study could be associated with lower cognitive outcomes for their child, e.g. the child having a disability.

Large demographic cohorts like the MCS have their strength in the random sampling based recruitment of participants in the surveys, but this is only true for the entire original sample: participants are missed at each stage of sampling, recruitment, follow up and agreement to provide

data to the study (Plewis, 2007). Sampling weights adjust for the design of the survey, but they have also been used in our analyses to make the sample more representative of the original sampled population. This allows us to say that our inferences apply to the UK born population of 2000-2001, but it requires the mechanism for attrition and refusal to participate being unrelated to our conditional inferences about the outcome. The life course event nature of returning to education makes it likely to be associated with changes of circumstances e.g. relocating for purposes of study or new employment which cause attrition and a transition possibly indicates a more successful progression for the parent, i.e. a greater increase in her social status. More generally this may explain the low estimate of outcomes of the youngest but most educated group, in that more resilient mothers may have moved on. A large cohort study of this kind is focused on the entire population, and the parents as much as the children, so uncooperative or impaired children may not have completed the assessment and have been excluded from our analysis. However, the poverty measure included may be capturing some of these more pathological problems, as well as representing the effect of material deprivation and poor nutrition which are also most significant at the youngest ages (Huston et al., 1994). Thus conclusions about the clinically impaired tail of the developmental scale, which would in any case be less responsive to changes in maternal SES, require another approach and different predictors.

Recommendations for policy and practice

While many policy child development characterise the socio-economics of the household as a fixed factor to control for, that approach is challenged by our analysis, which suggests the potential for poorer prospects to be affected by SES changes at the family level. Parents too young to have established themselves in socio-economic terms, and the range of their ages means that they are also at very different stages in their lives. For many mothers, their SES evolves over time, and our analysis saw concomitant benefits to their children in middle childhood. Yet the categorical nature of our educational data may mask a continuous trend in maternal cognitive ability being passed to the child (whether genetic or otherwise), with higher ability mothers in each category more likely to succeed at further education. For social policy, further maternal education or indeed poverty per se are certainly relevant but, identifying barriers faced by mothers in taking up further education after the birth of a child is salient, even though we are controlling already for a number of likely factors.

In the UK there is a programme for the surveillance of the development of young children. Health Visitors – community health nurses in other health systems – visit children the family home, from birth through to two or three years and sometimes beyond. They advise on breast feeding and early child care at first and later child development and behaviour: Language development and pre-literacy skills advice in such interventions are delivered via various media including verbally. Initial contacts focus on the parent, but this shifts to the child and “performance”; our analyses present opportunities for such services, which are not in current programmes. While there may be an informal narrative about making sure all children get their say, relative to their siblings, specific guidance is lacking, given the sizeable relation seen between outcome and birth order. And they could encourage mothers to return to education not only to benefit their own economic prospects (the current focus of government policy), but also for a beneficial effect on the wellbeing of the child.

Recommendations for future research

Experimental studies are preferred for inferences about changes in outcomes, before implementing social policies, but a policy randomising returns to education and maintaining this allocation is unrealistic as a study design. As social factors influence this decision and the outcome overall, a representative sample like a birth cohort is the ideal observational study, especially as it is large enough observe returns to education. Qualitative work exploring the dynamic attitudes of

parents to their education and their aspiration for their children (c.f. Domina & Roska, 2012) would complement this. Whether some parents link their own achievement with their children's and others do not, and if such attitudes in themselves make a difference to the child, would aid the development of policy.

The exposure model of language stimulated by input quality and quantity over the course child's development is one which requires wider interrogation and is a very high level (in that it may be mediated by a number of processes) characterisation of a mechanism for SES, as realised in educational level, affecting middle childhood language outcomes. It needs to be shown to have specificity to language/literacy as opposed to other cognitive outcomes and so elucidate whether the mechanism by which parental education has an effect is via language exposure of the child, as well as following through to adulthood. Input quality determined by academic educational level, and disrupted by older siblings, is consistent with empirical evidence here but needs consideration of paternal inputs, and the actual time spent with the child. Selection effects for returns to education and earlier and later siblings are likely to be present in terms of the concept of SES as well as measures like education level and should be accounted for in more complex analyses. As children become older, peer effects, subject to peer selection in relation to parental SES, should be seen to be more important, so that the effects of parental SES still seen, but more indirectly.

To present the exposure model of maternal education, we restricted the covariates included in our models but there are other factors which go broader and deeper, e.g. paternal factors and co-parenting behaviours (Lamb, 2010). In another analysis of the same outcome we compared the relations of maternal and paternal reading to the child and noted the increasing importance of paternal reading as the child moves into middle childhood (Law, King, & Rush, 2014). So there is potential to examine how the maternal education factor is seen to have an influence, at how it is related to the presence, education level and parenting behaviours of her partner. Our model also showed older siblings restricting these beneficial outcomes, and detailed consequences of the observed relations can be explored. If the effect of siblings is that they ameliorate the input quality associated with the education of parents, parenting practices with these children should make a difference, and we should be able to see a similar result for twins as seen by McMahon et al. (1998). Unfortunately cohort studies do not contain enough twins to test this and a study like TEDS does not contain siblings for us to compare to, but as twin studies are significant sources of evidence (Harlaar et al., 2007), large cohorts could oversample them as they do other population groups. The suggestion that genetics could influence SES (Trzaskowski et al., 2014), and particularly changes to it, makes good data on domains of cognitive development coupled with genetic material in large representative samples with good measurement of SES factors a priority for funders.

Overall, word reading has substantial associations with factors of environmental origin but in the UK, early years education focuses on the development of literacy skills, so that the educational process lessens the overall relation of external environmental factors on literacy specifically. This may be especially relevant in more disadvantaged groups of children who may have had less exposure to educational opportunities prior to starting in school (Becker, 2011), so not accounting for early education can be attenuating the observed effects. The measure available to this study was word reading but oral language skills or indeed other cognitive skills that are less a focus of educational provision should demonstrate a more pronounced direct effect of maternal education. Similarly, if Coates and Messer (1996) are replicable, our finding that parity has a negative association with word reading might not be replicated for other aspects of oral language (e.g. pragmatics or narrative). Then the trade-off between parity and increasing maternal education might be less pronounced and the effects of parental education increase might be even more marked than it is for single word reading. Similarly one might include issues associated with locus of control (which is possible in the MCS) or family history of learning difficulties (which is not).

CONCLUSION

Any large study of child development over time should take account of the changing status of the family and the relative age of adults whose children's outcomes are being compared. The data show a consistently positive message about the relation of the mother's further study to the child's early literacy, taking into account other interrelated aspects of family environment, replicating the findings of Magnuson et al. (2009).

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FIGURES AND TABLES

Figure 1 Seven year outcome by educational attainment and maternal age

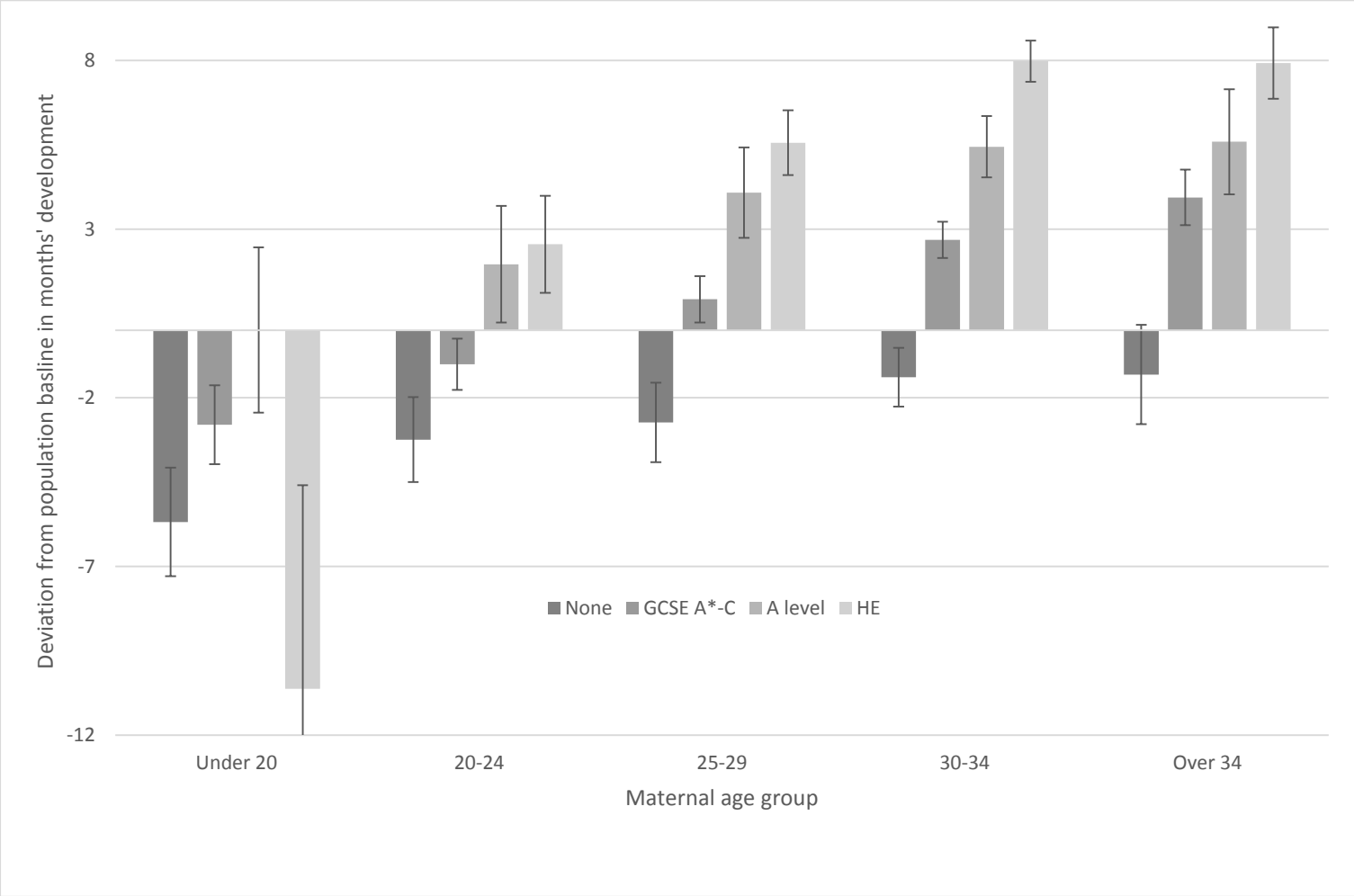

Table 1 Total and sub-populations for socio-demographic characteristics (%)

			Gaining Qualifications		
	Population			Higher level	
Factor	Responses	Sampled	LEL[3]	Total	A levels
Female child	48.8	48.7	52.9	50.2	46.2
Poverty[1]	31.4	28.3	25.5	38.5	41.1
Parity					
1	41.4	42.2	38.1	42.0	48.4
2	36.6	36.4	39.4	38.8	37.4
3	14.8	14.6	18.4	14.1	10.2
4	5.0	4.6	3.9	4.1	4.0
5+	2.1	2.1	0.2	1.1	0.0
Maternal age[2]					
<20	8.6	7.3	5.2	14.5	21.0
20-24	17.9	16.0	14.5	23.7	34.0
25-29	28.1	27.2	28.1	28.5	29.3
30-34	28.9	31.7	33.8	21.3	13.1
35+	16.4	17.8	18.4	11.9	2.5
Maternal education[2 4]					
University	26.2	29.1	60.4	-[5]	-[5]
A levels	9.6	10.1	8.9	20.1	-[5]
O levels/GCSEs A*-C	36.0	35.5	28.1	48.5	72.6
GCSEs D-G/None	28.2	25.5	2.6	31.4	27.4
Total (N)	12385	18055	446	641	115

[1]Poverty corresponds to household equivalised income below 60% median

[2]At birth of child

[3]Qualifications gained at lower or equivalent level than those already held

[4]Highest academic qualifications corresponding to stages: University = any higher education qualification; A levels = academic school leaving at age 18; O levels/GCSEs (A*-C) = academic school leaving at age 16 updated to general school leaving at high level in 1986; GCSEs(D-G)/None = non-academic school leaving qualifications at age 16 or no formal qualifications at an academic level

[5]These gain types are impossible by design

Table 2 Uncontrolled predictions[1] of outcome for socio-demographic groups

Predictor	M	SE	n	%N
Male child	-1.3	0.21	6644	54
Female child	1.4	0.18	6338	51
No Poverty	2.8	0.16	8517	69
Poverty[2]	-6.0	0.27	3898	31
Parity				
1	1.6	0.21	5374	43
2	0.4	0.24	4573	37
3	-2.7	0.38	1926	16
4	-5.2	0.69	652	5
5+	-7.5	1.03	277	2
Maternal age				
<20	-6.1	0.49	1115	9
20-24	-3.4	0.34	2330	19
25-29	-0.2	0.27	3652	29
30-34	2.7	0.25	3756	30
35+	2.4	0.35	2129	17
Maternal education				
University	6.4	0.25	3251	26
A levels	3.3	0.42	1193	10
O levels/GCSEs A*-C	-0.5	0.23	4466	36
GCSEs D-G/None	-6.2	0.28	3506	28

[1]Values are uncontrolled number of developmental months of difference from sample average on the BAS Single Word Reading outcome at age 7
[2]Poverty corresponds to household equivalised income below 60% median

Table 3 Crosstabulation of predicted[1] outcome [mean (SE) n] by age and education

	Age Group				
Education	<20	20-24	25-29	30-34	35+
University	-7.48 (4.24)	2.00 (1.14)	5.54 (0.47)	7.58 (0.38)	6.76 (0.50)
	17	176	907	1321	831
A levels	-0.64 (1.82)	1.16 (1.19)	3.28 (0.74)	4.52 (0.73)	3.95 (1.01)
	56	185	367	375	210
GCSEs	-4.29 (0.80)	-2.45 (0.50)	-0.54 (0.45)	0.99 (0.40)	1.76 (0.62)
	402	893	1273	1270	628
None	-7.98 (0.70)	-6.09 (0.55)	-5.97 (0.54)	-5.17 (0.64)	-5.90 (0.89)
	565	959	962	664	356

[1]Predictions for each maternal age/initial education combination are uncontrolled average number of developmental months of difference from sample average on the BAS Single Word Reading outcome at age 7

Table 4 Effect estimates[1] for different specification of acquired maternal education

Gain Indicator	B (SE)	95% CI
A levels[3]	4.32 (1.76)	[0.88, 7.77]
LEL qualifications[2]	-0.30 (0.83)	[-1.92, 1.32]
New highest level	1.85 (0.77)	[0.33, 3.36]

Note All values represent predicted number of developmental months of difference on the BAS Single Word reading outcome at age 7; each estimate is independently estimated in a model with all other covariates (gender, poverty, age, initial education and parity)

[1]B corresponds to the parameter estimate conditional on covariates in full regression model

[2] LEL qualifications = lower or equivalent level qualification gain, in contrast to higher level qualification gain

[3]A levels corresponds to those mothers gaining A levels having had only lower level qualifications at the child's birth

Table 5 Final model predicting reading vocabulary at seven years

Predictor	B (SE)	95% CI	n	%N
A level gain	4.32 (1.76)	[0.86, 7.77]	109	0.7
Parity				
2	-2.09 (0.37)	[-2.81, -1.37]	4703	36.5
3	-4.67 (0.53)	[-5.70, -3.64]	1906	14.8
4	-5.83 (0.89)	[-7.56, -4.09]	645	5.0
5+	-6.49 (1.23)	[-8.89, -4.09]	274	2.1
Poverty	-3.89 (0.43)	[-4.74, -3.04]	3884	30.1
Female	2.73 (0.32)	[2.11, 3.35]	6271	48.9
Age Group				
<20	-5.47 (1.17)	[-7.77, -3.18]	1104	8.4
20-24	-3.69 (0.76)	[-5.17, -2.20]	2305	17.7
25-29	-1.76 (0.69)	[-3.11, -0.41]	3610	28.0
35+	1.26 (0.82)	[-0.34, 2.87]	2107	16.7
Education[1]				
HE	5.30 (0.61)	[4.11, 6.50]	3243	26.6
A levels	2.76 (0.89)	[0.98, 4.54]	1190	9.6
None	-4.07 (0.87)	[-5.77, -2.37]	3497	27.8
Age × Education[1]				
<20 × HE	-13.13 (6.04)	[-24.98, -1.29]	17	0.1
<20 × A levels	-0.05 (2.45)	[-4.75, 4.85]	56	0.4
<20 × None	1.19 (1.61)	[-1.97, 4.34]	564	4.5
20-24 × HE	-1.74 (1.44)	[-4.57, 1.09]	176	1.5
20-24 × A levels	0.21 (1.73)	[-3.18, 3.61]	185	1.5
20-24 × None	1.84 (1.26)	[-0.62, 4.31]	956	7.6
25-29 × HE	-0.66 (0.96)	[-2.53, 1.21]	904	7.3
25-29 × A levels	0.40 (1.34)	[-2.24, 3.03]	366	3.0
25-29 × None	0.42 (1.18)	[-1.90, 2.73]	960	7.6
35+ × HE	-1.31 (1.06)	[-3.40, 0.76]	829	6.9
35+ × A levels	-1.11 (1.56)	[-4.17, 1.94]	210	1.7
35+ × None	-1.18 (1.47)	[-4.07, 1.71]	355	2.8

Note Reference category is male child, first born, above poverty threshold, maternal age of 30-34 and maternal education of GCSEs (A*-C) at birth of child; all estimated are for number of developmental months of difference on the BAS Single Word reading outcome at age 7

[1]HE = higher education; None = no academic qualification or only D-G grades at GCSE